BusWorks® 900PB Series
ProfiBus/RS485 Network I/O Modules

Model 963PB 12 Channel Analog Current Input
Model 964PB 12 Channel Analog Voltage Input

USER'S MANUAL

ACROMAG INCORPORATED
30765 South Wixom Road
Wixom, MI 48393-2417 U.S.A.

Tel: (248) 624-1541
Fax: (248) 624-9234

Copyright 2002, Acromag, Inc., Printed in the USA.
Data and specifications are subject to change without notice.

8500690E

TABLE OF CONTENTS

Symbols on equipment:

Means Refer to User's Manual (this manual) for additional information".

The information of this manual may change without notice. Acromag makes no warranty of any kind with regard to this material, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. Further, Acromag assumes no responsibility for any errors that may appear in this manual and makes no commitment to update, or keep current, the information contained in this manual. No part of this manual may be copied or reproduced in any form without the prior written consent of Acromag, Inc.

IMPORTANT SAFETY CONSIDERATIONS

You must consider the possible negative effects of power, wiring, component, sensor, or software failure in the design of any type of control or monitoring system. This is very important where property loss or human life is involved. It is important that you perform satisfactory overall system design and it is agreed between you and Acromag, that this is your responsibility.

GETTING STARTED

MOUNTING AND DIMENSIONS..... 3
CONTROLS & INDICATORS..... 3
ISOLATION BARRIERS..... 3
SETTING SLAVE ADDRESS..... 4
CONNECTIONS..... 4
- **DIN-Rail Mounting And Removal..... 4**
- **Network..... 5**
- **Power..... 6**
- **Analog Inputs..... 6**
- **Earth Ground..... 7**

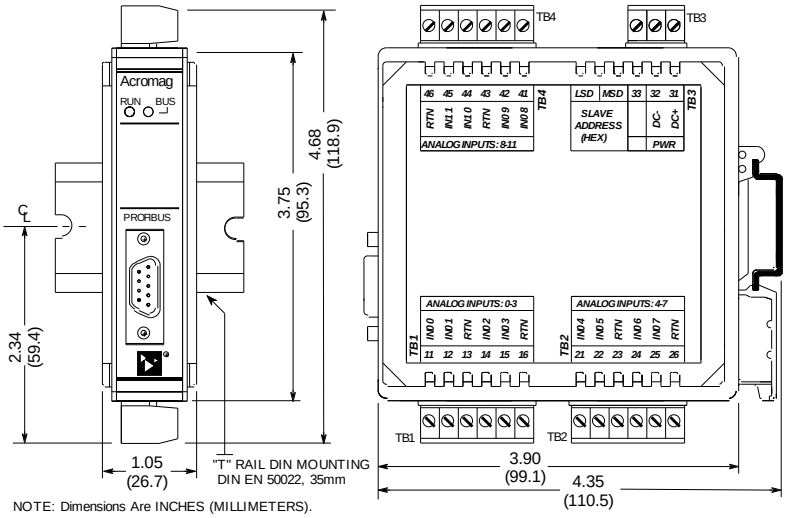
TROUBLESHOOTING..... 8
- **Tips For Building ProfiBus Networks..... 8**
- **Top Four Common ProfiBus Problems..... 8**
- **Troubleshooting Tools..... 8**
- **Using Connectors To Troubleshoot..... 9**
- **Diagnostics Function..... 9**
- **Diagnostics Table..... 10**

CALIBRATION..... 10

TECHNICAL REFERENCE

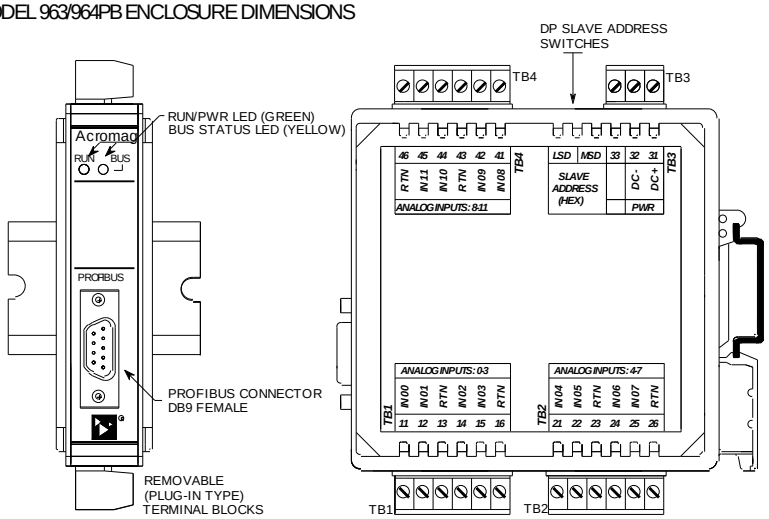
KEY FEATURES..... 12
HOW IT WORKS..... 13
SPECIFICATIONS..... 14
- **Model Numbers..... 14**
- **Analog Inputs..... 14**
- **General Specifications..... 15**
- **Enclosure/Physical..... 15**
- **Agency Approvals..... 16**
- **Environmental..... 16**
- **Communication Interface..... 17**
- **Controls & Indicators..... 19**
- **Module Specific Parameters..... 19**
- **Data Types..... 19**

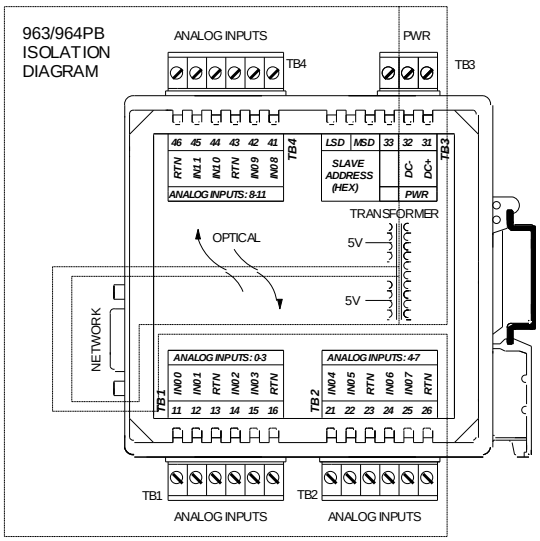
Windows® is a registered trademark of Microsoft Corporation.
Profibus® is a registered trademark of ProfiBus Trade Organization.
All trademarks are the property of their respective owners.



NOTE: Dimensions Are INCHES (MILLIMETERS).

MODEL 963/964PB ENCLOSURE DIMENSIONS





MOUNTING AND DIMENSIONS

Unit mounts to "T" type DIN rails (35mm, type EN50022).

Units may be mounted side-by-side on 1-inch centers.

WARNING: *IEC Safety Standards may require that this device be mounted within an approved metal enclosure or sub-system, particularly for applications with exposure to voltages greater than or equal to 75VDC or 50VAC.*

CONTROLS & INDICATORS

Green Run LED will stay ON if power is on and unit is OK, and will blink if unit fails.

Yellow BUS LED will turn ON if module is in data exchange mode.

ISOLATION BARRIERS

Dashed Lines denote isolation barriers.

The input circuit, network, and power circuit are isolated from each other for safety and noise immunity.

SETTING SLAVE ADDRESS

Address is set to 126 (7EH) from factory. This address is reserved for commissioning purposes only.

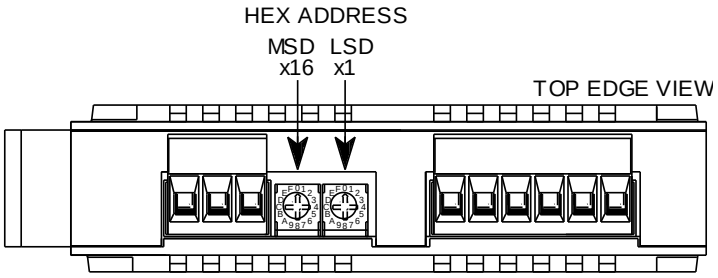
Locate hexadecimal address switches in recessed opening next to power terminals.

Use a screwdriver to rotate these switches to set a unique valid address from 0 to 125.

If the switches are set to a valid address from 0-125, then the switch setting determines the slave address and the Set Slave Address software command will be rejected.

If these switches are instead set to 126 (7EH) upon power-up, the unit will retrieve its address from the internal EEPROM, which is modified via the Set Slave Address command.

If these switches are set to 255 (FFH) upon power-up, this will return the address in EEPROM to 126 (7EH).



SET SWITCHES TO A VALID SLAVE ADDRESS FROM 0 TO 125 (00H TO 7DH)

1. Choose a slave address from 0-125 and locate highest MSD number less than this address. Set MSD switch to this number's corresponding HEX digit.

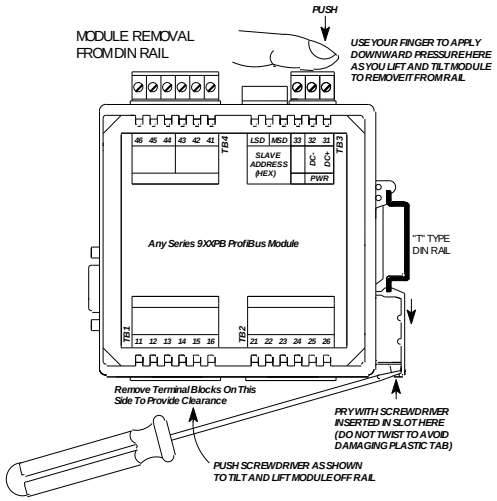
MSD x16		0	16	32	48	64	80	96	112	128	144	160	176	192	208	224	240
	HEX	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
LSD x1	DEC	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	HEX	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F

2. Determine the DECimal remainder and set the LSD switch to its corresponding HEX digit.

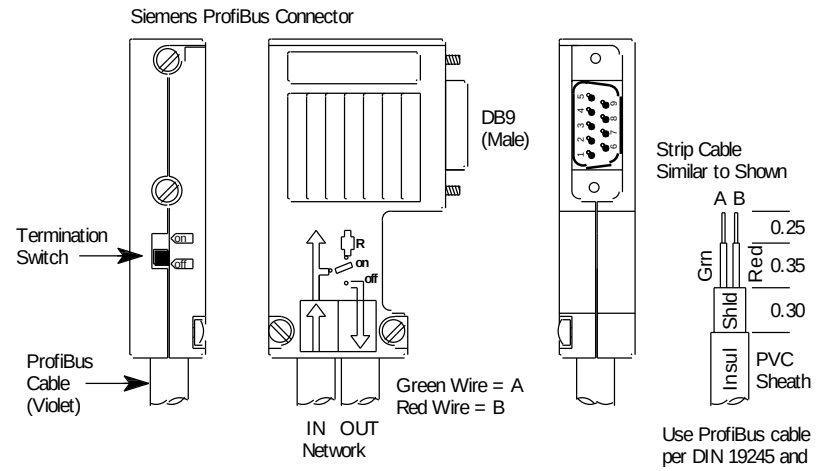
The address stored in the internal EEPROM is modified via the Set Slave Address command. If the address switches are set to 126 (or 126 to 254) upon power-up, the module will retrieve the last address stored within its EEPROM (126 from the factory). With both the internal EEPROM and external switch addresses set to 126, the unit will await the Set Slave Address command after power-up, before proceeding to the parameterization state (address 126 cannot be used in data exchange mode and is reserved for commissioning purpose only). You must use the Set Slave Address command to change the internal (EEPROM) address following power-up in order to proceed. However, if the switches are set to an address less than 126 upon power-up, then the switches determine the slave address and the EEPROM setting is ignored. You can later restore the internal EEPROM setting to 126 by powering the unit up with the address switches set to 255 (FF). You would then power the unit up again with these switches set to 126 in order to place the unit in commissioning mode.

CONNECTIONS

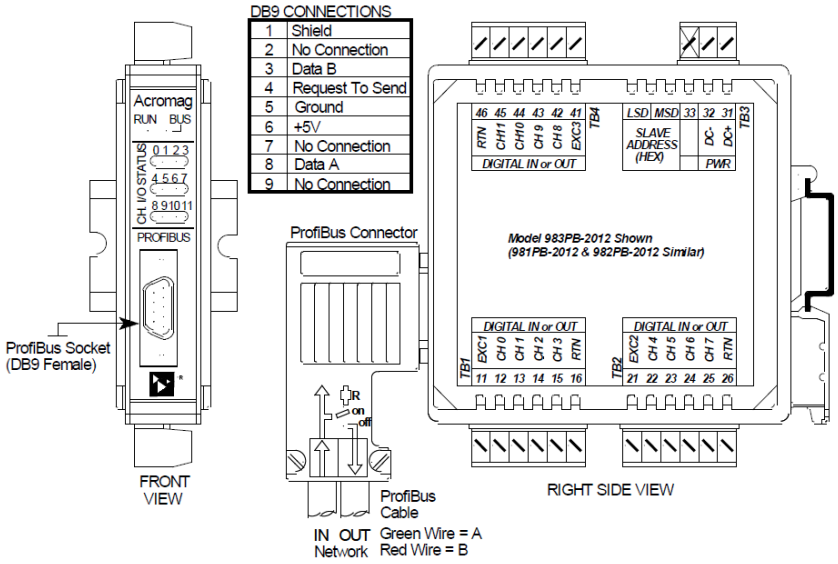
DIN-Rail Mounting & Removal


PUSH
MODULE REMOVAL FROM DIN RAIL
USE YOUR FINGER TO APPLY DOWNWARD PRESSURE HERE AS YOU LIFT AND TILT MODULE TO REMOVE IT FROM RAIL
Any Series 9XXPB ProfiBus Module
"T" TYPE DIN RAIL
Remove Terminal Blocks On This Side To Provide Clearance
PRY WITH SCREWDRIVER INSERTED IN SLOT HERE (DO NOT TWIST TO AVOID DAMAGING PLASTIC TAB)
PUSH SCREWDRIVER AS SHOWN TO TILT AND LIFT MODULE OFF RAIL

When attaching the module to the T-type DIN rail, angle the top of the unit towards the rail and locate the top groove of the adapter over the upper lip of the rail. Firmly push the unit towards the rail until it snaps into place. To remove, first separate the input terminal block(s) from the bottom side of the module to create a clearance to the DIN mounting area. Next, while holding the module in place from above, insert a screwdriver into the lower arm of the DIN rail connector and use it as a lever to force the connector down until the unit disengages from the rail (do not twist the screwdriver to avoid damaging plastic).



Do not mix RS485 A & B connections. Green wire is A, red wire is B.
You MUST terminate the network at both ends only.
Termination resistors are integrated in the ProfiBus connector.
When you switch termination ON, the out-going connections
are disconnected from the network.



CONNECTIONS

Network

Use ProfiBus connectors similar to the one shown at left (Siemens version shown).

Always use ProfiBus cable per DIN 19245 and EN 50170.

When building cables, do not mix A & B connections. Green wire is A, Red wire is B.

The connector must have built-in inductors in order to operate at the higher baud rates.

GSD Files:

963PB-2012 ACRO06F4.GSD
Ident_Number=06F4 Hex

964PB-2012 ACRO06F5.GSD
Ident_Number=06F5 Hex

IMPORTANT: *Do not connect earth ground to logic Ground (DB9 Pin 5). Earth Ground should connect to cable Shield (common to DB9 Pin 1).*

Note that Acromag modules also support the optional RTS direction control signal at Pin 4.

Network Length

Use Type A ProfiBus cable per EN 50170. Keep line lengths less than the length indicated below for your transmission rate. For baud rates not shown, the lower length of the closest range end points apply (i.e. 100M at 3Mbps).

Bus Segment Length Limit Per Baud Rate For Type A Bus Cable

BAUD	9.6K	19.2K	93.75K	187.5K	500K	1.5M	12M
Type A	1200M	1200M	1200M	1000M	400M	200M	100M

Termination

The network must be terminated at both ends only. Most ProfiBus connectors include a switch for termination as shown above. Note that this switch will also disconnect the outgoing network signal.

CONNECTIONS

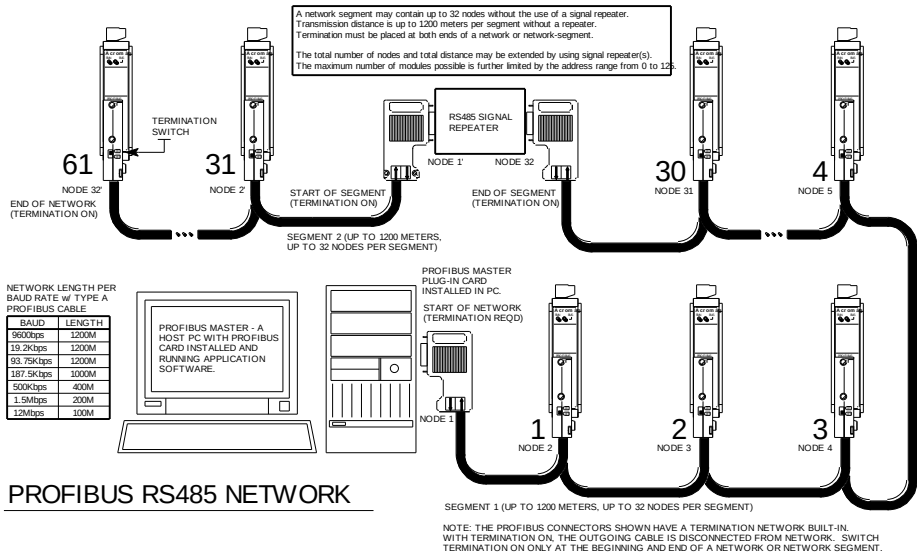
Network

Example ProfiBus System Connections

Up to 125 slave modules may network together with a class 1 master using four repeaters (one repeater every 31 nodes). Address 0 is typically reserved for the class 1 master.

Note: 12Mbps installations require a minimum cable length of 1M between stations.

TIP: A recommended RS485 repeater for ProfiBus is the Siemens 6ES79720AA01-0XA0.

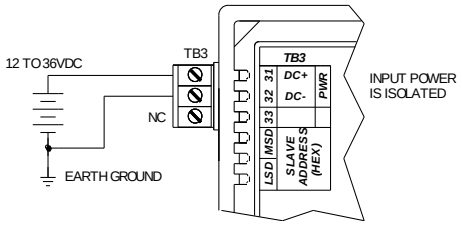

A network segment may contain up to 32 nodes without the use of a signal repeater.
Transmission distance is up to 1200 meters per segment without a repeater.
Termination must be placed at both ends of a network or network-segment.
The total number of nodes and total distance may be extended by using signal repeater(s).
The maximum number of modules possible is further limited by the address range from 0 to 125.
TERMINATION SWITCH
RS485 SIGNAL REPEATER
NODE 1'
NODE 32
61
NODE 32'
END OF NETWORK (TERMINATION ON)
31
NODE 2'
START OF SEGMENT (TERMINATION ON)
END OF SEGMENT (TERMINATION ON)
30
NODE 31
4
NODE 5
SEGMENT 2 (UP TO 1200 METERS, UP TO 32 NODES PER SEGMENT)
NETWORK LENGTH PER BAUD RATE w/ TYPE A PROFIBUS CABLE
BAUD LENGTH
9600bps 1200M
19.2Kbps 1200M
93.75Kbps 1200M
187.5Kbps 1000M
500Kbps 400M
1.5Mbps 200M
12Mbps 100M
PROFIBUS MASTER - A HOST PC WITH PROFIBUS CARD INSTALLED AND RUNNING APPLICATION SOFTWARE.
PROFIBUS MASTER PLUG-IN CARD INSTALLED IN PC.
START OF NETWORK (TERMINATION REQD)
NODE 1
1
NODE 2
2
NODE 3
3
NODE 4
PROFIBUS RS485 NETWORK
SEGMENT 1 (UP TO 1200 METERS, UP TO 32 NODES PER SEGMENT)
NOTE: THE PROFIBUS CONNECTORS SHOWN HAVE A TERMINATION NETWORK BUILT-IN. WITH TERMINATION ON, THE OUTGOING CABLE IS DISCONNECTED FROM NETWORK. SWITCH TERMINATION ON ONLY AT THE BEGINNING AND END OF A NETWORK OR NETWORK SEGMENT.

Power

Voltage	Current
12VDC	200mA
15VDC	151mA
24VDC	95mA
36VDC	67mA

CAUTION: Risk of Electric Shock – More than one disconnect switch may be required to de-energize equipment before servicing.

✓ Connect 12-36V DC to the power terminals labeled DC+ & DC-. Observe proper polarity. For supply connections, use No. 14 AWG wires rated for at least 75°C. **CAUTION:** Do not exceed 36VDC peak.



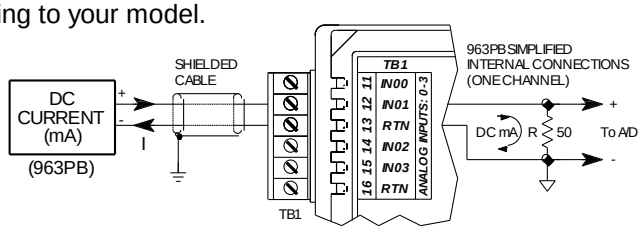
IMPORTANT – External Fuse: If unit is powered from a supply capable of delivering more than 1A to the unit, it is recommended that this current be limited via a high surge tolerant fuse rated for a maximum current of 1A or less (for example, see Bel Fuse MJS1).

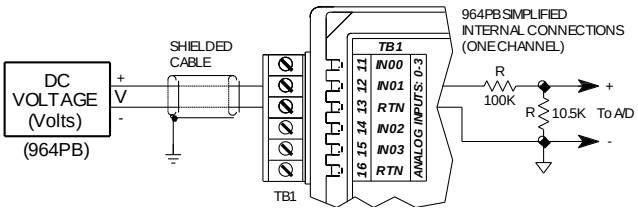
Analog Inputs

Input is DC current (963PB), or DC voltage (964PB).

Inputs share common (RTN) and are not isolated channel-to-channel.

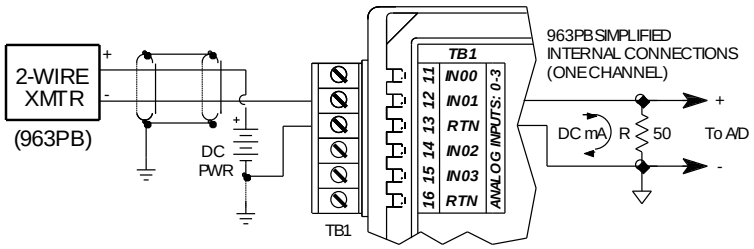
✓ Connect analog input signals to the input terminals as shown below according to your model.



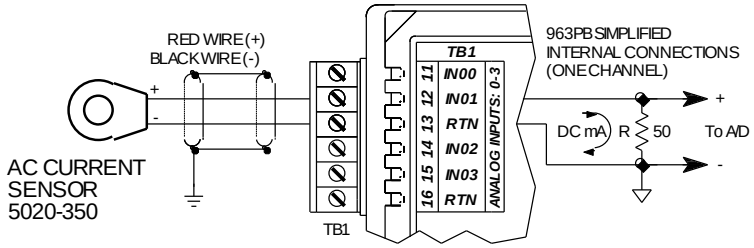


CONNECTIONS

Analog Inputs



Connection To A 2-Wire Transmitter (963PB Only)



Connection To Acromag AC Current Sensor 5020-350.

✓ Connect Earth Ground as shown in the connection drawings above. Additionally, ground the ProfiBus cable as shown below.

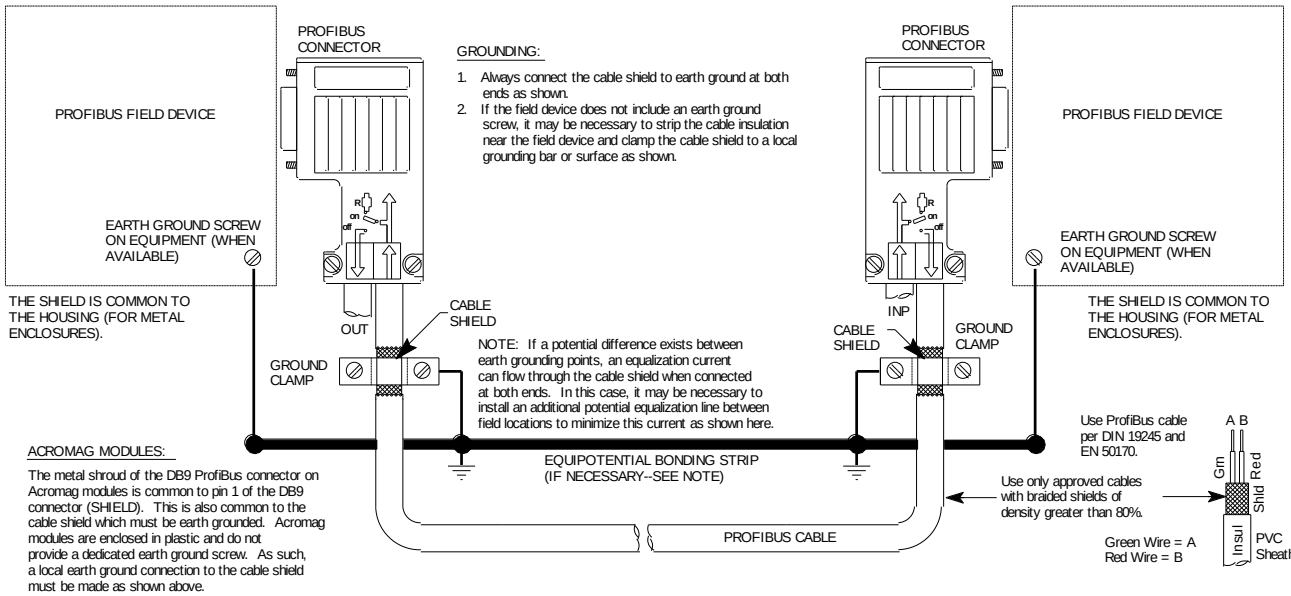
The ground connections noted are recommended for best results. If sensors are already grounded, use caution and avoid making additional ground connections which could create ground loops.

The plastic module housing does not require earth ground.

Earth Ground

Warning: *To comply with safety and performance standards, use shielded cable and connect earth ground as noted. Failure to use good wiring and grounding practices may be unsafe and hurt performance.*

PROFIBUS WIRING AND GROUND


PROFIBUS FIELD DEVICE
PROFIBUS CONNECTOR
EARTH GROUND SCREW ON EQUIPMENT (WHEN AVAILABLE)
THE SHIELD IS COMMON TO THE HOUSING (FOR METAL ENCLOSURES).
OUT
CABLE SHIELD
GROUND CLAMP
GROUNDING:
1. Always connect the cable shield to earth ground at both ends as shown.
2. If the field device does not include an earth ground screw, it may be necessary to strip the cable insulation near the field device and clamp the cable shield to a local grounding bar or surface as shown.
NOTE: If a potential difference exists between earth grounding points, an equalization current can flow through the cable shield when connected at both ends. In this case, it may be necessary to install an additional potential equalization line between field locations to minimize this current as shown here.
EQUIPOTENTIAL BONDING STRIP (IF NECESSARY--SEE NOTE)
INP
CABLE SHIELD
GROUND CLAMP
PROFIBUS CABLE
Use ProfiBus cable per DIN 19245 and EN 50170.
Use only approved cables with braided shields of density greater than 80%.
A B
Grn
Red
Shld
Insul
PVC Sheath
Green Wire = A
Red Wire = B
ACROMAG MODULES:
The metal shroud of the DB9 ProfiBus connector on Acromag modules is common to pin 1 of the DB9 connector (SHIELD). This is also common to the cable shield which must be earth grounded. Acromag modules are enclosed in plastic and do not provide a dedicated earth ground screw. As such, a local earth ground connection to the cable shield must be made as shown above.

TROUBLE-SHOOTING

The module routinely performs internal diagnostics following power-up or reset. During this period, the green "Run" LED will flash for a moment. If the diagnostics complete OK, the "Run" LED will stop flashing after a few seconds and remain ON. This indicates the unit is operating normally. Once the unit has passed through the initialization, parameterization, and configuration states, and is in data exchange mode, the yellow BUS LED will be ON. If the BUS LED is OFF and the unit is connected to the network, then this is indicative of an initialization problem.

Tips For Building ProfiBus Networks

- Follow the ProfiBus installation guidelines.
- Use the recommended cable and connectors of the standard.
- Verify that none of the wires are broken or shorted.
- Don't mix the A & B lines. Use green wire for A and red wire for B.
- Do not exceed the recommended segment length for the baud rate.
- Make sure that there are no more than 32 RS-485 devices per segment (including the master device and the repeater).
- Check for proper termination of all copper-wire network segments (an RS-485 segment must have a termination resistor at both ends of the segment only).
- All activated terminations must be powered all the time. If this is not possible, then consider using an active-termination box.
- Check whether the station address is set to the correct value.
- If your network connects between buildings or runs through hazardous environments, consider the use of fiber-optics.
- Avoid drop lines and keep their length within the specified maximum. For T-drops, consider using repeaters and active-bus terminations.

Top Four Common ProfiBus Problems

1. Incorrect slave address set at the slave.
2. ProfiBus connector between the master and slave has its termination switch turned ON.
3. Incorrect module configuration sent to slave.
4. Configuration is based on outdated GSD file information.

Troubleshooting Tools

There are several models of handheld devices on the market that simplify the installation and troubleshooting of ProfiBus networks. The more sophisticated units include LCD displays that read out errors directly. Two of these of these devices are referenced below:

Hand-Held ProfiBus Network Maintenance Tools

Manufacturer	Part Number	Special Features
Siemens	BT 200	Primarily a Cable Tester
Comsoft	NetTest II Set 4000-7-06C-J	Includes DP Mono-Master Functionality

In general, these devices can be used to check the network wiring before devices are connected to the bus and are often used to indicate:

- Whether the A and B lines have been switched.
- Whether a short exists between the A & B lines and shield.
- The occurrence of a wire-break in the A or B line, or shield line.
- Improper termination.

Troubleshooting Tools

These devices can also be used to check the RS-485 interface of ProfiBus devices after they have been connected. They may include the following functions:

- Create a list of all stations connected to a network (useful for identifying missing or "offline" devices).
- Can test individual stations and help identify duplicate addresses.
- Measure the distance along a network segment to verify whether it complies with the Profibus requirements for distance and data rate.
- Detect signal reflections along the network, useful for locating bus line interruptions and discontinuities.

Acromag strongly suggests the use of these tools for building and maintaining ProfiBus networks.

Note that Profichip also offers a Profibus connector (PA003100) that includes 4 network diagnostic LED's that may be helpful in trouble-shooting your network (see table below).

Using Connectors To Troubleshoot

The standard 9-pin ProfiBus connectors with integrated termination resistors are also helpful in troubleshooting segments of the network. In most of these connectors, when the termination resistors are switched ON, the outgoing portion of the connector is disconnected. As such, you can selectively disable segments of the network until you find the branch that is causing the problem. For example, if your handheld unit is connected to the beginning of a network and indicates a wire break, you can selectively switch off portions of the network and recheck your handheld unit to help pin point the portion of the network that is causing the problem. Below are some ProfiBus connectors that we recommend:

Preferred Bus Connectors

Manufacturer	Part Number	Special Features
Siemens	6ES7972-0BA12-0XA0	Switchable Termination
Siemens	6ES7972-0BB12-0XA0	Adds PB Interface (Piggy Back DB9 For Diagnostic Connection)
Profichip	PA003100	Adds PB Interface and Four Diagnostic LED's For Trouble-Shooting.

Diagnostics Function

ProfiBus includes a rich diagnostic function that can be used to troubleshoot ProfiBus devices. This function contains 6 bytes of standard diagnostic information, plus up to an additional 238 bytes of device specific diagnostic information. Most configuration tools support this command and can read the diagnostic information from the Profibus device.

TROUBLE-SHOOTING

Diagnostics Table

If your problem still exists after checking your wiring and reviewing this information, or if other evidence points to another problem with the unit, an effective and convenient fault diagnosis method is to exchange the module with a known good unit. Acromag's Application Engineers can provide further technical assistance if required. Complete repair services are also available from Acromag.

SYMPTOM	POSSIBLE CAUSE	POSSIBLE FIX
Yellow BUS LED does not light.	Initialization Problem. LED ON if module in data exchange state. Both the internal EEPROM and external address switches are set to an address of 126.	Check Station Address. Is GSD file correct. Check for wiring error. Module is awaiting Set Slave Address command in order to complete initialization. Alternately, set switches from 0-125 and re-power.
Cannot communicate.	Is power ON at the module and/or RS485 converter?	Check power. Is green RUN LED ON?
	Is address correct?	Check address settings at the slave.
	Is the termination switch of the Profibus connector at the prior node turned on?	Switch Termination on only at the **ends** of the network. With termination switch on, the outgoing connections are disconnected from the network chain.
Yellow BUS LED turned OFF.	Communication Halted.	Cycle power to reset unit. Investigate grounding.
Continuous flashing green RUN LED.	Internal firmware problem.	Return the module for service.
Many Communication Errors.	Missing Termination Resistors?	Termination resistors must be placed only at both ends of a network or network segment.
	Is baud rate too high for distance?	Maximum distance is limited below 1200 meters as baud rate is increased above 93.75Kbps (see Table).

CALIBRATION

IMPORTANT: *This module has already been calibrated at the factory and recalibration is not normally required, except as necessary to correct for long term component aging, or to satisfy your company's maintenance requirements. Do not attempt to recalibrate this module unless absolutely required, as miscalibration will negatively affect the module's performance.*

The following table gives the calibration values for these models. These are the input signals required to calibrate the range endpoints. Your success in recalibrating the input will depend upon the accuracy and precision of your signal source. Note that on the 963PB-2012, the 4-20mA range is a sub-range of the 0-20mA range and is automatically calibrated at the same time. If calibration is required, all three ranges of both models should be done.

INPUT RANGE	ZERO Cal (Cal Lo)	FS Cal (Cal Hi)
963PB-2012 (12 Current Inputs)		
0 to 20mA & 4 to 20mA	1.0mA	20.0mA
0 to 11.17mA	1.0mA	11.17mA
0 to 1mA	0.25mA	1.00mA
964PB-2012 (12 Voltage Inputs)		
-10V to +10V DC	-10.0V	+10.0V
-5V to +5V DC	-5.0V	+5.0V
-1V to +1V DC	-1.0V	+1.0V

CALIBRATION

These models have two I/O Configuration definitions in their GSD files, one for normal operation, and another for accomplishing calibration. The normal data exchange definition supports 12 input words (your measured value). A second calibration definition supports 12 input and 12 output words. The master software will allow you to choose which mode the slave will assume—Input Mode or Configuration Mode. The method used to transfer information between the master and slave will vary widely between systems. The steps below represent the minimum steps necessary to accomplish software calibration. If you choose to perform calibration and select Configuration Mode, the master will download the 12I/12O configuration during the startup sequence, and the module may then be calibrated as follows:

Note: For best results, be sure to use a precision signal source capable of reproducing the nominal endpoint signals at least as accurate as the module itself (better than ±0.1% of span). Always allow the module to warm up a few minutes prior to calibration.

1. With your master software, select the "Configuration Mode" from the GSD file when setting up the master to communicate with the module.
2. With user parameterization bytes 0-2, set the ranges that are to be calibrated.
3. Apply the zero calibration signal (see table below) to the input to be calibrated and allow the input to settle a few seconds.
4. Write FFH into the low-order byte of the channel's output word several times (to ensure transmission). In Configuration Mode, the module will automatically calibrate the channel's zero value when FFH is detected. Then write 00H into the low-order byte to complete zero calibration.
5. Apply the full-scale calibration signal (CalHi, see table) to the input to be calibrated and allow the input to settle a few seconds.
6. Write FFH into the high-order byte of the channel's output word several times (to ensure transmission). In Configuration Mode, the module will automatically calibrate the channel's full-scale value when FFH is detected. Then write 00H into the high-order byte to complete full-scale calibration.
7. Repeat steps 3-6 for the other channels of the same range.
8. With user parameterization bytes 0-2, select the next range to be calibrated.

   Note (963PB): The 4-20mA range is calibrated when the 0-20mA range is calibrated and is not calibrated separately. All other ranges are calibrated separately.

9. Repeat steps 3-7 for all channels of this range.
10. Repeat steps 8-9 until all input ranges have been calibrated.
11. When finished calibrating, use the master software to return the module to the normal "Input Mode" to prevent miscalibration.

After completing calibration, the module should be reconfigured as required and placed in the normal "Input Mode" configuration (I/O configuration is 12 input words only). In general, your software allows you to select the normal "Input Mode" configuration, and the slave will then be taken off-line by the master and reconfigured. If reconfiguration is successful, the slave module will pass to the data exchange state with a normal I/O configuration.

TECHNICAL REFERENCE

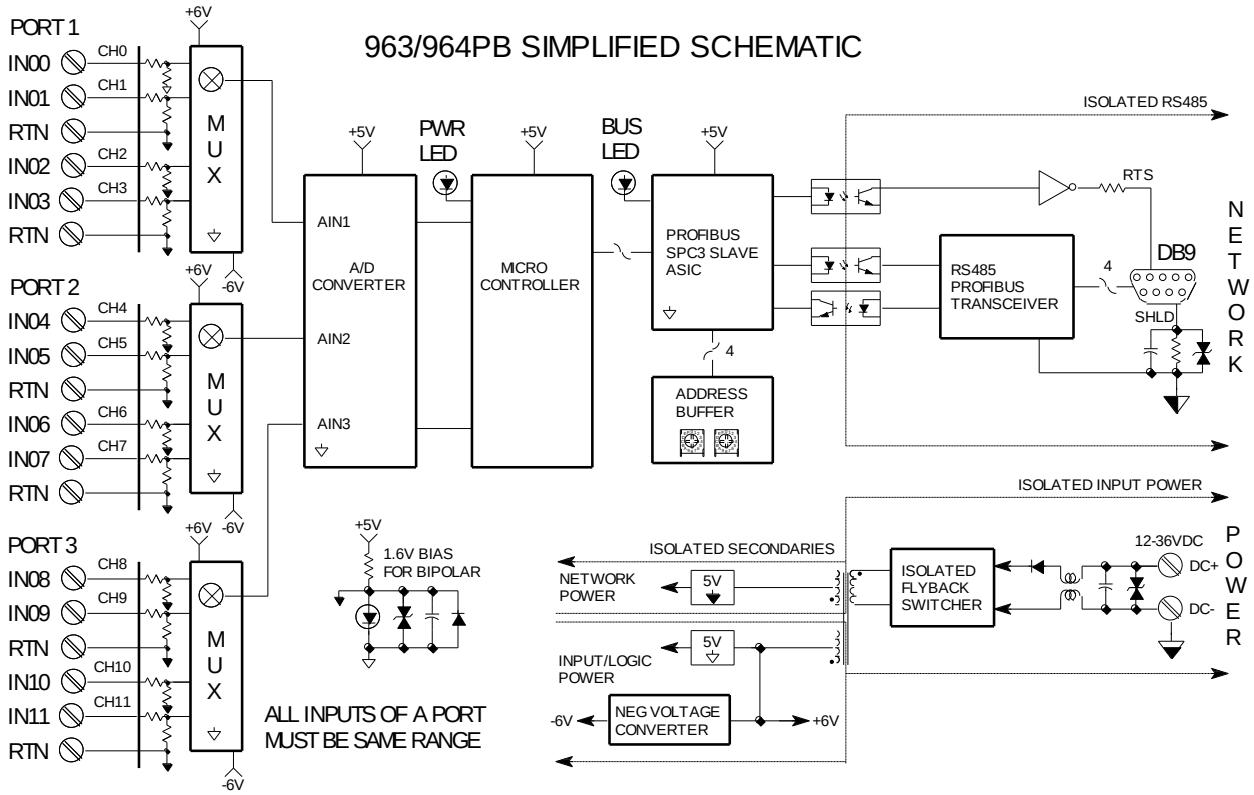
KEY FEATURES

- **PTO Certified** - Unit certified by the ProfiBus Trade Organization.
- **Safety Agency Approvals** – CE, UL, & cUL listed, plus Class 1; Division 2; Groups A, B, C, D approvals.
- **Fully Independent Slave w/ Direct I/O Connection** – Self-contained unit does not require special bus couplers, power supply, or rack mount to operate.
- **Plug-In Terminal Blocks & DIN-Rail Mount -** Make mounting, removal, and replacement easy.
- **Industry Standard ASIC** – Uses Siemens SPC3 intelligent ASIC to talk ProfiBus.
- **Isolated RS485/ProfiBus Network Interface** – Highly immune to noise and can operate over long distances. Allows many modules to network together.
- **Auto-Baud Rate Detection** – The baud rate is set automatically.
- **High-Speed Data Rates** – Half-duplex RS485 up to 12M baud.
- **Includes RTS Support** – ProfiBus interface includes the optional RTS (Request-To-Send) direction control.
- **Flexible Multi-Range Analog Inputs –** Select either DC current or DC voltage input signals according to your model.
- **Port-to-Port Range Variability** – Each terminal port (4 channels) can have different ranges configured (channels of the same port share the same range).
- **Optional AC Current Input (963PB Only) –** An optional AC current sensor can be purchased separately to support AC current inputs.
- **Precise High-Resolution A/D Conversion** – Modules use high-resolution, low noise, sigma-delta, analog-to-digital conversion for high accuracy and reliability.
- **Nonvolatile Reprogrammable Memory** – Allows the functionality of this device to be reliably reprogrammed thousands of times.
- **Fully Isolated** – Input channels (as a group), network, and power are all isolated from each other for safety and increased noise immunity.
- **LED Indicators** – A green LED indicates power. A yellow bus status LED indicates proper network connection and unit in data exchange mode on the bus.
- **Watchdog Timer Built-In** – Standard for the ASIC and operates in the data exchange mode if communication with the master is lost.
- **Self-Diagnostics & Diagnostic Watchdog** - For easy maintenance and troubleshooting. Includes a hardware watchdog timer built into the microcontroller that causes it to initiate a self reset if the controller ever "locks up" or fails to return from an operation in a timely manner.
- **Wide-Range DC-Power** – Wide range diode-coupled for use with redundant supplies, and/or battery back-up.
- **Hardened For Harsh Environments** - For protection from RFI, EMI, ESD, EFT, & surges. Has low radiated emissions per CE requirements.
- **Wide Ambient Operation** – Reliable over a wide temperature range.

HOW IT WORKS

These input modules will interface with up to twelve analog input channels of DC current or voltage according to the model number, and provide an isolated RS485/ProfiBus interface for configuring and monitoring the inputs. Input channels are arranged in three groups (ports) of four inputs, which are driven to separate channels of the A/D. Because each port feeds a different A/D channel, each channel of the port must have the same input range. However, different ports may use different input ranges. Current inputs sink into a precision 50Ω resistor (963PB). Voltage inputs feed precision 10:1 resistive dividers (964PB). A multiplexer is used to connect the voltage from each channel of a port to a channel of the A/D converter (one A/D channel per port). The A/D converter then applies gain to the signal, converts the analog signal to digital, and then digitally filters the signal. The digitized signal is then transmitted serially to the microcontroller. The microcontroller completes the transfer function according to the input type and range per its embedded program. Configuration and calibration parameters are stored in non-volatile memory integrated within the microcontroller. These modules implement the ProfiBus protocol via an industry-standard SPC3 ASIC from Siemens. This ASIC acts like a RAM or UART chip to the internal microcontroller and completely handles the requirements of the protocol standard. The ASIC will transfer network data to the microcontroller and automatically provide the response to the bus. The ASIC handles the ProfiBus protocol and communicates with the network via an optically isolated RS485 transceiver. A wide input switching regulator (isolated flyback) provides isolated power to the I/O circuit and the RS485 port. Refer to the simplified schematic shown below to gain a better understanding of the circuit.

963/964PB SIMPLIFIED SCHEMATIC



SPECIFICATIONS

These DIN-rail mount, ProfiBus DP slave, input modules include twelve analog input channels for DC current (963PB), or DC voltage (964PB), and provide an isolated RS485/ProfiBus network interface. Units are DC-powered with reverse polarity protection. Analog inputs (as a group), network, and power are isolated from each other. Input channels share common. Non-volatile reprogrammable memory in the module stores configuration and calibration information.

Model Numbers

963PB-2012 (Current)
964PB-2012 (Voltage)

The ProfiBus model prefix "900" denotes the Series 900. The "PB" suffix denotes ProfiBus. Select 963PB for current input, and 964PB for voltage input. The four digit suffix of this model number represents the following options, respectively: "2" = ProfiBus DP; "0" = Default; "12" = 12 Channels.

Analog Inputs

Twelve analog input channels with a common (RTN) connection for DC current or voltage applications only. The unit must be wired and configured for the intended input type and range (see Connections Section for details). The unit can be configured to accept one of several input ranges described below.

DC Current (963PB Only): Configurable for 0 to 20mA, 4-20mA, 0-11.17mA, and 0-1mA DC nominal input ranges. A precision 49.9Ω current sink resistor converts the input current to a voltage that is processed by the A/D converter. An optional external sensor is required to monitor AC current signals (Acromag Model 5020-350). This sensor generates a DC milliampere signal of 0 to 11.17mA for the module (see Table 1 below for scaling to AC current).
Current Input Reference Test Conditions: 4 to 20mA current input; Ambient Temperature = 25°C.
Input Overvoltage Protection: Bipolar Transient Voltage Suppressers (TVS), 5.6V clamp level typical.
Optional AC Current Sensor (Model 5020-350, For Use With 961PB/963PB): This sensor is a toroidal instrument transformer that converts a sinusoidal 50-60Hz AC current signal into a low level DC milliampere signal of 0 to 11.17mA. The input AC current range is a function of the number of turns placed through the toroid as shown in Table 1 below. This sensor is isolated and requires no calibration or adjustment. When used with a 961PB/963PB module, it provides redundant input isolation and may facilitate input-to-input isolation of this six channel unit.

Table 1: Optional AC Current Sensor Turns & Range

AC Current Input Range	Primary Turns	Sensor Output (Red/Black Wires)
0 to 20A AC	1	0 to 11.17mA DC
0 to 10A AC	2	"
0 to 5A AC	4	"
0 to 2A AC	10	"
0 to 1A AC	20	"

Analog Inputs

The output wires of this sensor are polarized with red as (+) plus and black as (-) minus. Normally these output wires are attached to one end of a user supplied cable, while the other end connects to the 963PB's process current input terminals.

Input Burden: A function of the wire gauge resistance used for primary turns (the current carrying wire being monitored).

AC Current Sensor to Transmitter Wiring Distance: 400 feet maximum for 18 gauge wire. Other wire gauges can be used as long as the resistance of both wires is less than 5Ω.

Input Overload: The AC current sensor will withstand overload conditions as follows:

- 20 times full scale for 0.01 seconds.
- 10 times full scale for 0.1 seconds.
- 5 times full scale for 1.0 second.

DC Voltage (964PB Only): A 10:1 input divider is installed at the input (using divider resistor values of 100K and 10.5K). Configurable for bipolar DC voltage ranges of -1V to 1V, -5V to 5V, and -10V to 10V.

Input Impedance: 110.5KΩ.

Voltage Input Reference Test Conditions: -10 to 10V DC Input; Ambient Temperature = 25°C.

Input Overvoltage Protection: Bipolar Transient Voltage Suppressers (TVS), 18V clamp level typical.

General Specifications

Accuracy: Accuracy is better than ±0.05% of span, typical, for nominal input ranges. This includes the effects of repeatability, terminal point conformity, and linearization, but does not include sensor error.

Measurement Temperature Drift: Better than ±50ppm/°C (±0.005%/°C).

Analog to Digital Converter (A/D): 16-bit Σ-Δ converter.

Resolution: 0.005% or 1 part in 20000 (963PB), 0.0025% or 1 part in 40000 (964PB, full bipolar range).

Input Conversion Rate: 180ms per channel, or 2.16s for all twelve channels.

Input Filter: Normal mode filtering, plus digital filtering, optimized and fixed per input range within the Σ-Δ ADC.

Input Filter Bandwidth: -3dB at 3Hz, typical.

Noise Rejection (Normal Mode): 40dB @ 60Hz, typical with 100Ω input unbalance.

Noise Rejection (Common Mode): 140dB @ 60Hz, typical with 100Ω input unbalance.

Enclosure and Physical

Dimensions: 1.05 inches wide, 4.68 inches tall, 4.35 inches deep. Refer to the dimensions drawing at the front of this manual.

DIN Rail Mount: Type EN50022; "T" rail (35mm).

I/O Connectors: Removable plug-in type terminal blocks rated for 15A/300V; AWG #12-24 stranded or solid copper wire.

Network Connector: 9-pin D-Sub connector (female) with metal housing and 4-40 jack screw support.

Enclosure and Physical

D-Sub Pin	Signal	Description
1	SHLD	Shield (Connect to Earth Ground)
2	NC	No Connection
3	A	Data A (TxD/RxD+)
4	RTS	Request To Send
5	GND	RS485 Logic Ground
6	+5V	+5V
7	NC	No Connection
8	B	Data B (TxD/RxD-)
9	NC	No Connection

Case Material: Self-extinguishing NYLON type 6.6 polyamide thermoplastic UL94 V-2, color beige; general purpose NEMA Type 1 enclosure.
Printed Circuit Boards: Military grade FR-4 epoxy glass.
Shipping Weight: 1 pound (0.45 Kg) packed.

Agency Approvals

ProfiBus Trade Organization (PTO): Certified.
Safety Approvals: CE marked (EMC Directive 89/336/EEC); UL Listed (UL508, UL1604); cUL Listed (Canada Standard C22.2, No. 142-M1987 & 213-M1987); Hazardous Locations: Class 1; Division 2; Groups A, B, C, and D.

Environmental

Operating Temperature: -25°C to +70°C (-13°F to +158°F).
Storage Temperature: -40°C to +85°C (-40°F to +185°F).
Relative Humidity: 5 to 95%, non-condensing.
Power Requirements: Non-polarized 11-36V DC SELV (Safety Extra Low Voltage). Observe proper polarity. Current draw may decrease up to 14% as the baud rate increases to 12MB (data below is at 9600 baud).

CAUTION: *Do not exceed 36VDC peak, to avoid damage to the module.*

External Fuse: *Select a high surge tolerant fuse rated for 1A or less to protect unit.*

Supply	963PB-2012 or 964PB-2012 Current Draw
12V	181mA Typical, 200mA Maximum
15V	137mA Typical, 151mA Maximum
24V	86mA Typical, 95mA Maximum
36V	61mA Typical, 67mA Maximum

CAUTION: Risk of Electric Shock – More than one disconnect switch may be required to de-energize equipment before servicing.

Power Supply Effect:
Volts: Less than ±0.001% of output span change per volt for rated power supply variations.
60/120 Hz Ripple: Less than 0.01% of output span per volt peak-to-peak of power supply ripple.

Note that input channels are not isolated channel-to-channel.

Isolation: Input channels (as a group), power, and network circuits are isolated from each other for common-mode voltages up to 250VAC, or 354V DC off DC power ground, on a continuous basis (will withstand 1500VAC dielectric strength test for one minute without breakdown). Complies with test requirements of ANSI/ISA-82.01-1988 for voltage rating specified.
Installation Category: Designed to operate in an Installation in a Pollution Degree 2 environment with an installation category (over-voltage category) II rating.
Electromagnetic Interference Immunity (EMI): Measurement shift is less than ±0.25% of input span for interference from switching solenoids, commutator motors, and drill motors.

Environmental

These limits represent the minimum requirements of the standard, but product has typically been tested to comply with higher standards in some cases.

Electromagnetic Compatibility (EMC) -
Minimum Immunity Per European Norm EN50082-1:

Electrostatic Discharge (ESD) Immunity: 4KV direct contact and 8KV air-discharge to the enclosure port per EN61000-4-2.

Radiated Field Immunity (RFI): 10V/M, 80 to 1000MHz AM and 900MHz keyed carrier, per EN61000-4-3 and ENV50204.

Electrical Fast Transient Immunity (EFT): 2KV to power, and 1KV to signal I/O per EN61000-4-4.

Conducted RF Immunity (CRFI): 10V rms, 150KHz to 80MHz, per EN61000-4-6.

Surge Immunity: 0.5KV per EN61000-4-5.

Emissions Per European Norm EN50081-1:

Radiated Frequency Emissions: 30 to 1000MHz per EN55022 Class A

WARNING: This is a Class A product. In a domestic environment, this product may cause radio interference in which the user may be required to take adequate measures.

IMPORTANT: Power, input, and output (I/O) wiring must be in accordance with Class I, Division 2 wiring methods Article 501-4(b) of the National Electrical Code, NFPA 70 for installations in the U.S., or as specified in section 18-1J2 of the Canadian Electrical Code for installations within Canada and in accordance with the authority having jurisdiction.

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, and D, or non-hazardous locations only.

WARNING – EXPLOSION HAZARD – Substitution of components may impair suitability for Class I, Division 2.

WARNING – EXPLOSION HAZARD – Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

Communication Interface

Interface Standard: 3-wire RS-485 multi-drop, half-duplex (D, D-bar, and Common), asynchronous.

Command/Response Protocol: Standard ProfiBus DP (Master/Slave) protocol per European Norm EN50170.

Baud Rate: Supported baud rates are 9600, 19.2K, 45.45K, 93.75K, 187.5K, 500K, 1.5M, 3M, 6M, and 12M bits per second, auto-detected. Maximum transmission length is dependent on baud rate selection (range is up to 1200M at 9600bps, or up to 100M at 12Mbps). Refer to the following table for maximum transmission distances at supported baud rates using recommended type A (<30pF/M), or alternately type B (<60pF/M) bus wire (see EN50170):

Communication Interface

Baud Rate	NETWORK LENGTH	
	Type A	Type B
9600 bps	1200M	1200M
19.2K bps	1200M	1200M
≤ 93.75K bps	1200M	1200M
187.5K bps	1000M	600M
500K bps	400M	200M
1.5M bps	200M	NA
≤ 12M bps	100M	NA

Parity: Even parity.
Stop Bits: One.
Communication Distance: Up to 1200 meters without a repeater.
Address: Set via two rotary hexadecimal switches adjacent to the power terminals, or alternately via the Set Slave Address command. Valid setting is 0-125 (7 bits). Address 126 (7EH) is the default factory address and is reserved for commissioning purposes only. Address 127 (7FH) is reserved by the software as a global address for broadcast messages. If the address switches are set to 126 upon power-up (or 126 to 254), then the unit will retrieve its address from its internal EEPROM rather than the switches. The internal EEPROM setting is modified via the Set Slave Address command. Powering up with switches set to 255 (FFH) will cause the internal EEPROM setting to revert back to 126 (7EH), which may be used to recommission the module. If both the internal EEPROM address and the switches are set to 126 upon power-up (this is the initial state from the factory), the module will await the Set Slave Address command before completing initialization and assuming the data exchange mode.
IMPORTANT (Address Setting): The internal EEPROM address setting and external switch setting is 126 from the factory. As such, the module will await the Set Slave Address command following power-up and will not proceed to exchange data, unless the external switches are instead set to an address from 0-125, or the internal setting is changed to an address from 0-125 via the Set Slave Address command.
Maximum Message Size: Up to 32 bytes recommended, extendable up to 244 bytes of data/node/message, plus 11 bytes of overhead (frame).
ProfiBus Character: 11 bits (1 start bit + 8 data bits + 1 even parity bit + 1 stop bit). Applies to all bytes, including frame bytes.
Bus Idle State: "1" (a start bit causes line to go to "0"). An idle state of at least 33 Tbits (sync-time) must be provided between messages. Note: 1Tbit at 12Mbaud = 1/12000000bit/sec = 83nsec.
Ident_Number: 06F4 Hex (963PB-2012), 06F5 Hex (964PB-2012).
GSD File: ACRO06F4.GSD (963PB-2012), ACRO06F5.GSD (964PB-2012).
Network Capacity: Multi-drop up to 31 modules, plus a host, without a repeater. Up to 125 modules plus a host if four repeaters are used (one for every 31 nodes).
Network Termination: Use 220Ω "A" to "B", plus 390Ω "A" to GND, and 390Ω "B" to +5V. Use ±2%, 0.25W resistors.

Controls & Indicators

LED Indicators:

Run (Green) - ON indicates power is on and unit is OK. Flashing ON/OFF indicates unit is performing diagnostics (first few seconds following power-up), or has failed diagnostics (after a few seconds).

Bus (Yellow) – ON indicates unit has completed its initialization sequence and is in the data exchange mode on the network.

Switches:

Slave Address – Slave address is set via two rotary hexadecimal switches adjacent to the power terminals (see Address above).

Module Specific Parameters

This model includes four user parameterization bytes (User_Prm_Data) defined as shown at left.

Note that channels of the same port (every group of 4 channels) share the same configuration, but the configuration may vary port-to-port. All parameterization bytes take effect immediately. This model does not include any user defined diagnostic data (Ext_Diag_Data).

Byte	Description	Default
0	Do Not Use – Reserved for SPC3 ASIC.	NA
1	Channel 0-3 Range Select: 00H = 0-20mA (963PB), -10V to +10V DC (964PB). 01H = 4-20mA (963PB), -5V to +5V DC (964PB). 02H = 0-11.17mA (963PB), -1V to +1V DC (964PB). 03H = 0-1mA (963PB), Not Defined (964PB).	00H
2	Channel 4-7 Range Select: 00H = 0-20mA (963PB), -10V to +10V DC (964PB). 01H = 4-20mA (963PB), -5V to +5V DC (964PB). 02H = 0-11.17mA (963PB), -1V to +1V DC (964PB). 03H = 0-1mA (963PB), Not Defined (964PB).	00H
3	Channel 8-11 Range Select: 00H = 0-20mA (963PB), -10V to +10V DC (964PB). 01H = 4-20mA (963PB), -5V to +5V DC (964PB). 02H = 0-11.17mA (963PB), -1V to +1V DC (964PB). 03H = 0-1mA (963PB), Not Defined (964PB).	00H
4	Writing 55H to this byte will cause the module to restore its factory calibration. Note that 55H is not stored, but acts as a trigger. This byte always reads as 00H.	00H
5	Factory Use Only – Do Not Modify.	00H

Data Types

I/O values of Acromag 9xxPB modules are represented by the simple data types shown at left for temperature, percentage, and discrete on/off. Note that when transferring words, data bytes are transmitted using "Big Endian" format (MSB first, LSB second).

Data Types	Description
Percentage (This Model)	A 16-bit signed integer value with resolution of 0.005%/lsb. ±20000 is used to represent ±100%. For example, -100%, 0% and +100% are represented by decimal values –20000, 0, and 20000, respectively. The full range is –163.84% (-32768 decimal) to +163.835% (+32767 decimal).
Temperature	A 16-bit signed integer value with resolution of 0.1°C/lsb. For example, a value of 12059 is equivalent to 1205.9°C, a value of –187 equals –18.7°C. The maximum possible temperature range is –3276.8°C to +3276.7°C.
Discrete	A discrete value is generally indicated by a single bit of an 8-bit byte. The bit number/position typically corresponds to the discrete channel number. Unless otherwise defined for outputs, a 1 bit means the corresponding output is closed or ON, a 0 bit means the output is open or OFF. With active-high inputs, a value of 1 specifies the input is in its high state (usually >> 0V), while 0 specifies the input is in its low state (near 0V). With active-low inputs, a value of 1 means the input is ON (Active low near 0V), while 0 specifies the input is OFF or in its high state (usually >> 0V).

Notes:

Revision History

The following table shows the revision history for this document:

Release Date	Version	EGR/DOC	Description of Revision
12 DEC 02	A	BC/KLK	Release to Production.
18 MAR 03	B	BC/KLK	"DIN-Rail Mounting and Removal" Drawing Update per ECN 03C008.
28 OCT 03	C	BC/KLK	UL Update per ECN 03J022.
02 NOV 04	D	CAP/KLK	Added latest UL Information to Manuals and Labels per ECN 04J008.
02 FEB 15	E	FJM/MJO	Correction to connectors on DB9 Connections table.